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SUPERCONDUCTING FAULT CURRENT LIMITER

[Chodendo Genryu Sochi]

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/1[1]

Specification

1. Title of the invention

SUPERCONDUCTING FAULT CURRENT LIMITER

2. Claims /2

1. A superconducting fault current limiter, characterized by the fact that switches are installed for several current limiter units; they are connected in parallel; and one breaker is connected in series.

2. A superconducting fault current limiter, characterized by the fact that several current-limiting coils are connected in parallel in one very low-temperature container; a switch mechanism for connecting and cutting off each of the above-mentioned current-limiting coils is installed in a current lead for connecting a very low-temperature part and a normal-temperature part.

3. The superconducting fault current limiter of Claim 2, characterized by the fact that the above-mentioned switch mechanism consists of one changeover switch that switches the

[1] Numbers in the margin indicate pagination in the foreign text.

above-mentioned several current coils and connects them to the outside.

3. Detailed explanation of the invention

[0001]

(Technical field of the invention)

The present invention pertains to a superconducting fault current limiter, especially a constitution of a superconducting fault current limiter.

[0002]

(Prior art)

Figure 4 shows the constitution of a conventional superconducting fault current limiter shown in Japanese Kokai Patent Application No. Sho 64[1989]-21837, for instance.

[0003] In the figure, 1 and 2 are current limiter units, 1a and 2a are current-limiting coils, 1b and 2b are very low-temperature containers, 5a and 5b are breakers, 100a a control part for controlling opening and closing of the breakers 5a and 5b at a prescribed timing. Figure 5 shows details of the current limiter unit 1. 3a and 3b are current leads, and 4 a very low-temperature refrigerant. The current-limiting coil 1a as a superconducting wire is housed in the very low-temperature refrigerant 4 and connected to a normal-temperature part from a

very low-temperature part via the current leads 3a and 3b. Usually, the thermal load of the very low-temperature part is a heat permeation due to the conduction of a structural material (not shown in the figure), a heat radiation (not shown in the figure), and a heat permeation due to the conduction from the current leads 3a and 3b.

[0004] The current value of a trunk line system or load system is usually about several thousands A (ampere). In the superconducting fault current limiter connected to these systems, since it is necessary to send a large current, the sectional area of the current leads 3a and 3b, and the heat permeation to the very low-temperature part from them is sometimes increased most. Also, this phenomenon is similarly caused in the current limiter unit 2.

[0005] Next, the operation is explained. The superconducting fault current limiter shown in Figure 4 is usually connected in series to a system. For example, the breaker 5a is used in a closed state, and the breaker 5b is used in an open state. In a normal operation state, since the current-limiting coil 1a has a zero electric resistance, even if it is inserted in series, it has no negative influence on the system.

[0006] Next, in case an excessive current flows in the system due to short-circuit accident, etc., the excessive current flows

in the current-limiting coil 1a, however if it reaches a critical current value of the current-limiting coil 1a, the current-limiting coil 1a causes a superconducting fracture (quench), so that the coil has a large electric resistance. The short-circuit current flowing in the system can be suppressed by the electric resistance.

[0007] On the other hand, since the current flows in the quenched current-limiting coil 1a having a large electric resistance, the Joule loss of the current-limiting coil 1a is extremely increased, so that the temperature of the current-limiting coil 1a is raised.

[0008] Usually, at a time of a short circuit, the breaker 5a is opened after several cycles and input again after several hundreds ms (millisecond). At that time, the temperature of the current-limiting coil 1a is still high and is not in a superconductive state. Accordingly, in the prior art, during the re-input, the breaker 5b connected to the current-limiting coil 1b in a superconductive state is input. Thus, the current-limiting coil 1b in a superconductive state is connected to the system.

[0009]

(Problems to be solved by the invention)

Since the conventional superconducting fault current limiter had the above constitution, several units of very expensive breakers were required. The heat permeation into the very low-temperature part from the current leads was large, and the refrigerant was largely consumed.

[0010] The present invention solves the above-mentioned problems, and its purpose is to provide a superconducting fault current limiter that lowers the cost by reducing the number of breaker and can reduce a heat permeation into a very low-temperature part from current leads.

[0011]

(Means to solve the problems)

In order to achieve the above-mentioned purpose, the present invention provides a superconducting fault current limiter characterized by the fact that switches are installed for several current limiter units; they are connected in parallel; and one breaker is connected in series.

[0012] Also, the present invention provides a superconducting fault current limiter characterized by the fact that several current-limiting coils are connected in parallel in one very low-temperature container; a switch mechanism for connecting and

cutting off each of the above-mentioned current-limiting coils is installed in a current lead for connecting a very low-temperature part and a normal-temperature part.

[0013] Also, the present invention provides a superconducting fault current limiter characterized by the fact that the above-mentioned switch mechanism consists of one changeover switch that switches the above-mentioned several current coils and connects them to the outside.

[0014]

(Embodiments of the invention)

Embodiment 1

Figure 1 shows the constitution of the superconducting fault current limiter of an embodiment of the present invention. In Figure 1, 1, 1a, 1b, 2, 2a, and 2b are similar to those of the prior art. 6a and 6b are switches. A breaker 5a is one unit and is connected in series to them. The switches 6a and 6b are inexpensive, compared with the breaker 5a. 100 is a control part for controlling opening and closing the breaker 5 and the switches 6a and 6b at a prescribed timing.

[0015] Next, the operation is explained. In a normal operation state, one of the switches 6a and 6b is in a closed state, and one of them is in an open state. The breaker 5a is in a closed state. For the following explanation, here, it is assumed that

the switch 6a is in a closed state and the switch 6b is in an /3 open state.

[0016] In case an excessive current flows to a system due to short-circuit accident, etc., the excessive current flows in the current-limiting coil 1a, however if it reaches a critical current value of the current-limiting coil 1a, the current-limiting coil 1a causes a superconducting fracture (quench), so that the coil has a large electric resistance. The short-circuit current flowing in the system can be suppressed by the electric resistance.

[0017] On the other hand, since the current flows in the quenched current-limiting coil 1a, the Joule loss of the current-limiting coil 1a is extremely increased, so that the temperature of the current-limiting coil 1a is raised.

[0018] At a time of a short circuit, the breaker 5a is opened after several cycles by the control of the control part 100, and the switch 6a is opened. Then, the switch 6b is closed. When the breaker 5a re-input after several hundreds ms, since the switch 6b connected to the current-limiting coil 1b in a superconductive state is closed and the switch 6a is opened, the current-limiting coil 1b having a zero electric resistance is connected, so that a normal operation is resumed.

[0019] Embodiment 2

Figure 2 shows the constitution of the superconducting fault current limiter of another embodiment of the present invention. In Figure 2, parts shown by the same symbols as those of the above-mentioned embodiment represent the same or corresponding parts. 7a and 7b are current leads having functions of switches 70a and 70b as switch mechanisms in them, 10 is a very low-temperature container, 4 is a very low-temperature refrigerant, and 3a is a current lead.

[0020] Next, the operation is explained. In a normal operation state, one of the current leads 7a and 7b is in a closed state, and one of them is in an open state. The breaker 5a is in a closed state. For the following explanation, here, it is assumed that the current lead 7a is in a closed state and the current lead 7b is in an open state. In order to send a current to the current leads, the current leads are required to be electrically connected, however if they are electrically connected, they are also thermally connected, so that the heat permeation into the very low-temperature part is increased, so that the amount of very low-temperature refrigerant 4 being consumed is increased.

[0021] In order to reduce the heat permeation into the very low-temperature part, the current leads 7 and 7b that connect the

normal-temperature part and the very low-temperature part having a temperature difference may be thermally cut off. Like this embodiment, in case the current lead of one circuit among the parallel circuits of two circuits or more is used (in this case, the current lead 7a), the current lead 7b, which is not in use, is electrically cut off, so that it can also be thermally cut off. Therefore, with the introduction of the mechanism of the switches 70a and 70b into the current leads 7a and 7b, the heat permeation of the current lead which is not in use can be reduced. Thus, the heat permeation into the very low-temperature part can be reduced.

[0022] Embodiment 3

Figure 3 shows the constitution of the superconducting fault current limiter of another embodiment of the present invention. In Figure 3, parts shown by the same symbols as those of the above-mentioned embodiment represent the same or corresponding parts. In Figure 3, 8 is a current lead having a function of a changeover switch 80 as a switch mechanism in it. 81a and 81b fixed terminals, and 82 is a movable terminal. In Embodiment 2, the current leads have been separately mounted, however even if the changeover switch 80 is installed in one current lead 8, effects similar to those of Embodiment 2 can be

exerted. Also, the number of current lead being used can be reduced, contributing to the cost reduction.

[0023] Also, in the above-mentioned each embodiment, two units each of the current limit units, switches, or current-limiting coils have been explained. However, even if they are three or more units, the present invention can be similarly applied, and the corresponding effects can be obtained.

[0024]

(Effects of the invention)

As mentioned above, according to the present invention, switches are respectively installed in several current limiter units, they are connected in parallel, and one breaker is connected to them. Thus, since only one breaker is used, the cost is lowered.

[0025] Also, according to the present invention, two or more current-limiting coils are connected in parallel in one very low-temperature container, and a breaker mechanism is installed in current leads for connecting a very low-temperature part and a normal-temperature part. Thus, the heat permeation into the very low-temperature part from the current leads is reduced.

[0026] Also, according to the present invention, two or more current-limiting coils are connected in parallel in one very low-temperature container, and a changeover switch mechanism is

installed in current leads for connecting a very low-temperature part and a normal-temperature part. Thus, the heat permeation into the very low-temperature part from the current leads is reduced. Also, since switching is carried out by one changeover switch, the number of switch and the number of current lead can be reduced, so that the cost is lowered.

4. Brief description of the figures

Figure 1 shows the constitution of the superconducting fault current limiter of an embodiment of the present invention.

Figure 2 shows the constitution of the superconducting fault current limiter of another embodiment of the present invention.

Figure 3 shows the constitution of the superconducting fault current limiter of another embodiment of the present invention.

Figure 4 shows the constitution of a conventional superconducting fault current limiter.

Figure 5 shows the constitution of a conventional current limiter unit.

Explanation of symbols:

1, 2 Current limiter units

1a, 2a Current-limiting coils

1b, 2b, 10 Very low-temperature containers

3a, 7a, 7b, 8 Current leads

4 Very low-temperature refrigerant

5a Breaker

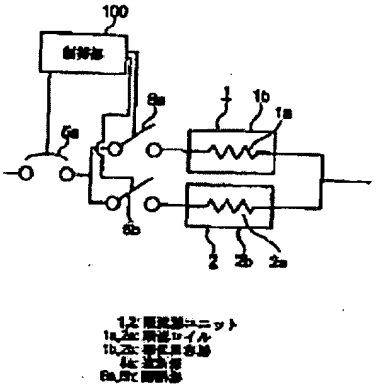
6a, 6b, 70a, 70b Switches

80 Changeover switch

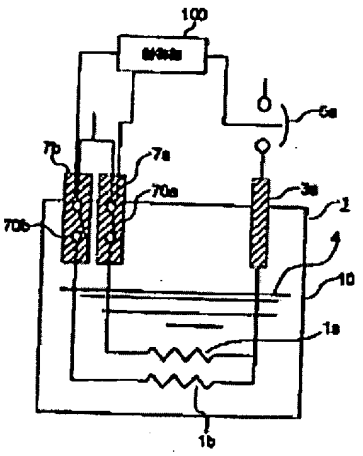
81a, 81b Fixed terminals

82 Movable terminal

【図1】



【図2】



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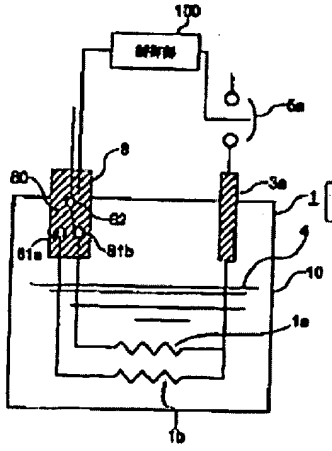

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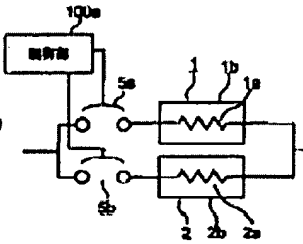

【図5】

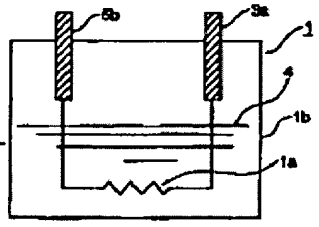

Figure 1:

1, 2 Current limiter units

1a, 2a Current-limiting coils

1b, 2b Very low-temperature containers

5a Breaker

6a, 6b Switches

100 Control part

Figure 2:

4 Very low-temperature refrigerant

3a, 7a, 7b Current leads

70a, 70b Switches

10 Very low-temperature container

100 Control part

Figure 3:

8 Current lead

80 Changeover switch

81a, 81b Fixed terminals

82 Movable terminal

100 Control part

Figure 4:

100a Control part